

Working with State Spaces

The Farmer-Fox-Chicken-and-Grain Problem:

A farmer needs to take a fox, chicken and sack of grain across a river using a small boat. He can only take one of the three items in the boat with him at one time. The fox must never be left alone with the chicken, and the chicken must never be left alone with the grain. How can he get everything across the river?

(a) Describe the initial state for this problem*. Assume they start on the left bank of the river and must get to the right bank.

Initial state: farmer, fox, chicken, and grain are all on the left side of the river. Namely,

Ffgc

(b) List a sufficient set of operators for the problem.

- Operator 1: Take chicken across the river to the right side
 - Precondition: neither fox and chicken or chicken and grain will be left alone during or after the move
 - State transformation: remove chicken from the left side
- Operator 2: Take chicken across the river to the left side
 - Precondition: neither fox and chicken or chicken and grain will be left alone during or after the move
 - State transformation: add chicken back to the left side
- Operator 3: Take grain across the river to the right side
 - Precondition: neither fox and chicken or chicken and grain will be left alone during or after the move
 - State transformation: remove grain from the left side
- Operator 4: Take grain across the river to the left side
 - Precondition: neither fox and chicken or chicken and grain will be left alone during or after the move
 - State transformation: add grain back to the left side
- Operator 5: Take fox across the river to the right side
 - Precondition: neither fox and chicken or chicken and grain will be left alone during or after the move
 - State transformation: remove fox from the left side
- Operator 6: Take fox across the river to the left side
 - Precondition: neither fox and chicken or chicken and grain will be left alone during or after the move
 - State transformation: add fox back to the left side

(c) How many states are there in the state space?

There are 16 possible state in the state space:

Ffgc (Initial)

Ffg, Ffc, Fgc, fgc

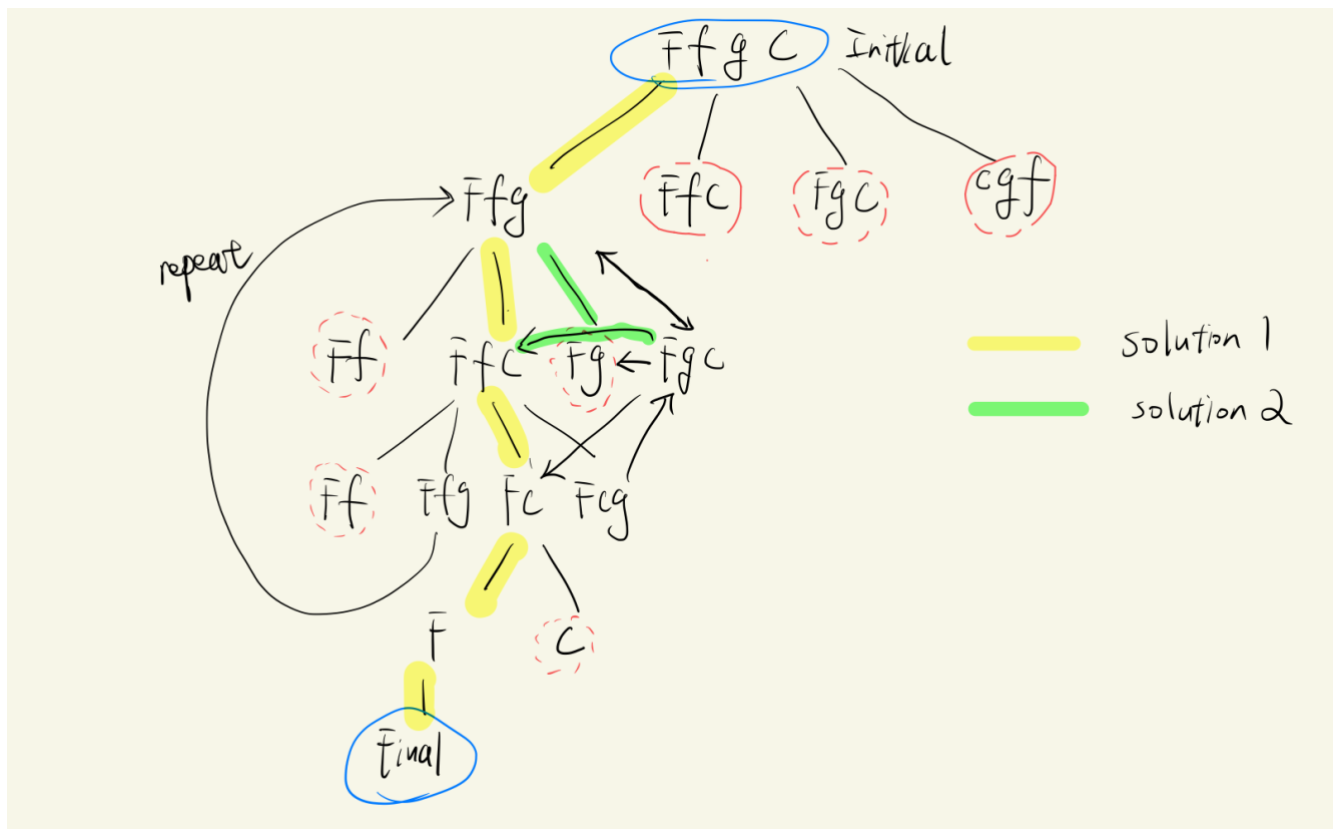
Ff, Fg, Fc, fg,fc, gc

F,f, g,c

Final state

(d) Draw the problem-space graph*.

The path stops when meets an illegal state (circled by red dotted line), so I didn't draw out all the possible states. The final state is in blue solid line.



(e) Highlight a solution path on the graph.

Solution is highlighted in the graph.

*Suggestion: represent each state by listing the initials of the items on the left bank. For example “Ffg” means the Farmer, fox, and grain are on the left bank (and the chicken is therefore on the right bank). If you draw the initial state on the left, you could use “number of operator applications from initial state” as the x coordinate for the layout (for the layout, pretend that the fox never eats the chicken, and the chicken never eats the grain. You can draw all the states, put a dotted oval around any “illegal state” (a state in which the fox would eat the chicken or the chicken would eat the grain).

Who were your groupmates for this activity? Write down their names and email addresses:

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provided by S. Tanimoto, 2021
